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ABSTRACT

A series of inspections for cassette recorders that can be performed to assure that the devices are acceptable is described. The inspections can be completed in 20 minutes and can be performed by instructional personnel. The series of inspection procedures includes tests of the intelligibility of audio, physical condition, tape speed, impulse reliability, response range, and torque delivered to the tape. It is suggested that acceptance testing could both avoid disruption of instruction and save money by obtaining repair or replacement under the warranty on the device. (Author/DGC)

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AFHRL-TR-74-101

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ACCEPTANCE INSPECTION FOR AUDIO CASSETTE RECORDERS

TECHNICAL TRAINING DIVISION
Lowry Air Force Base, Colorado 80230

December 1974

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MARTY R. ROCKWAY, Technical Director
Technical Training Division

Approved for publication.

HAROLD E. FISCHER, Colonel, USAF
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This technical memorandum describes a series of inspections for cassette recorders that can be performed to assure that the devices are acceptable. The inspections can be completed in 20 minutes and can be performed by instructional personnel. The series of inspection procedures includes tests of the intelligibility of audio, physical condition, tape speed, impulse reliability, response range and torque delivered to the tape. It is suggested that acceptance testing could both avoid disruption of instruction and save money by obtaining repair or replacement under the warranty on the device.

SUMMARY

Problem

With the advent of learning centers, use of cassette tape recorders within USAF has increased considerably. An important consideration is that the devices purchased be received in usable condition. Many installations do not have a routine procedure for doing functional inspection testing. This frequently results in defective devices being issued to students or instructors. Acceptance testing could both avoid the disruption of the instruction and also save money by obtaining repair or replacement under the warranty on the device.

Approach

This memorandum describes a series of inspections for cassette recorders that can be performed to assure that these devices are acceptable for their intended use. The inspections can be completed in 20 minutes.

Results

A series of tests, or inspection procedures, is proposed that can be completed on all cassette recorders, as they are received. These include inspection of intelligibility of audio, physical condition, tape speed, impulse reliability, response range, and torque delivered to the tape. If the device has record capability, this should also be checked. The essential aspects of acceptance testing are grouped together within the first inspection. The latter inspections are highly desirable, but may not be feasible in some instances.

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ACCEPTANCE INSPECTION FOR AUDIO CASSETTE RECORDERS

I. INTRODUCTION

With the advent of learning centers, many DoD installations are receiving audiovisual equipment in larger numbers than they are accustomed to. It is one thing to receive one or two devices for use by trained instructors. It is quite another to receive 50 devices for use in student carrels. Too often, the acceptance of 50 projectors or tape recorders consists of merely counting to make certain there are 50 boxes and signing the receipt. Little attention is paid to the condition of the device contained within the box, or for that matter whether it is even the expected model or type of device.

This memorandum is intended to suggest some methods of doing acceptance testing of audiovisual devices. It is directed particularly at the type of devices used in individualized instruction in learning centers. The present memorandum will be further restricted to the consideration of cassette tape recorders. However, the general methodology would be suitable for many other types of devices, including reel-to-reel recorders, slide projectors, filmstrip projectors, etc. While the procedures as described relate primarily to the inspection of new items as they are initially received, similar inspection might be warranted following transfer of equipment or after extended periods in which the devices have been inactive.

II. RATIONALE

There are several reasons for performing acceptance testing. One is to assure that the items purchased have in fact been received. While some may contend that receiving 50 boxes marked Cassette Players assures that the purchase request has been filled, there is equal merit in insisting that the contents be usable. Inspection on initial receipt facilitates claims for damage during shipment; it enables us to take advantage of repairs or replacement during the warrantee period; the devices in use tend to be more uniform in function; and inspections enable us to interact with the manufacturer to assure that his product is received in the condition he intended. The latter point is sorely overlooked by many personnel. Most of our suppliers wish to be considered highly reliable and are very interested in delivering products that satisfy the purchaser. In the long run, they lose more than we do if their equipment is delivered in a sub-standard condition that results in inferior performance.

Inspection testing often provides the only in-service training that the user receives in the operation of the equipment. If there is a standard inspection procedure such as described in the following pages, the using agency is assured that at least some of its personnel are familiar with the operation of the equipment. If difficulties are encountered, sales personnel or factory representatives can be consulted.

This in-service training is especially needed if the devices are the first of their type that you receive. For example, if it is the first cassette recorder that you have received, getting it into operation the first time may be a problem. If attempts to record something do not succeed, it is often very difficult to determine whether the recorder is defective or whether you have been making errors in following the directions. Overlooking a switch, plugging in a mike improperly, putting the cassette in wrong can all result in failure. While these should not occur, having software of known quality on hand initially to verify the operability of the device often provides just the clues it takes to decode the operational procedures the first time. Some devices that appear to be so simple have peculiarities that can be deceptively confusing.

Acceptance testing also encourages you to initiate records and procedures that are most useful in future purchases. If an experienced person does the initial inspection and records it, and if systematic maintenance records are kept, these provide good objective data for use in selecting equipment in the future. All too often knowledge about inferior products is concealed because the initial user had no experience to draw upon. If you put a standard cassette into 50 consecutive recorders, you soon learn what they should sound like. You also learn how controls should function. Without experience to draw on, it is often difficult to determine whether or not a device is functioning adequately or not. If the device cannot be turned on, that is one thing. But fans that sound "a little bit noisy" or voices that sound "fuzzy in some places" may or may not indicate that the device should be returned.

III. SELECTION OF TESTS

In setting up a series of inspections, some attention needs to be paid to the selection of types of tests to be made. A series of tests was required that could be done quickly, easily, and with available equipment. It was felt that it must be reasonable to expect a typical classroom instructor to perform the inspection, though it would ordinarily be done by maintenance personnel. Engineering background or electronics experience might help but certainly could not be a requirement. It was felt that the entire inspection should not take more than 20 minutes per device. The inspection equipment should be easily obtained on most bases or purchased readily. Probably the most difficult consideration involved "relevance to USAF instruction." For example, much of the literature available indicates that a good tape recorder should have a relatively flat response from 30 through 20K Hertz. It was felt that such specifications might be suitable for listening to a symphony in your living room but probably unjustifiable for inclusion in a learning carrel where audio is limited to oral instruction. Flutter and wow considerations were eliminated on similar grounds.

The major consideration was that some form of systematic test be completed. If nothing more were done than taking the device out of the carton, putting in a cassette with either voice or music on it, and listening for 15 seconds, a great deal would be accomplished. If this were to be done though, a little additional effort could produce reliable data that can be quantified. This enables the use of record sheets and precise comparisons between devices and between tests conducted at one time or place with those done later or at another location.

The result is a series of short tests that can be routinely applied. These include inspection of impulse reliability, intelligibility of audio, physical condition, tape speed, response range, and torque delivered to the tape. If the device has record capability, this should also be checked. The essential aspects of the inspection are grouped together within the first inspection. The latter ones are highly desirable, but may not be feasible in some instances.

IV. INSPECTION PROCEDURES

Figure 1 depicts a sample worksheet that can be used. Some such standardized form makes it much easier to record the findings in a way that they will be useful in the future. While the specifics will vary from base to base, the general format could remain the same.

To perform the inspection, you will need a work area that includes two 115V power outlets, copies of the worksheets, test cassettes, slide projector with test set of slides, a stop watch or watch with sweep second hand, a small speaker, and a VTVM or similar meter. If possible, an oscilloscope and the torque cassettes should be used.

The first unit to be inspected is taken out of its carton, placed on the work bench, and the identifying data recorded, as requested, at the top of the sheet. This provides a permanent record of the make, model, and serial number of the particular device being inspected together with the inspector's name, the date of the inspection, and whether the inspection was completed for initial acceptance, preventative maintenance, following repair, etc.

Technically, most of the devices used are cassette players, but for our purposes here the term "recorder" will be used in the generic sense to include the whole family of devices using compact audio cassettes.

Impulse test: The recorder is placed on the inspection table and connected to a projector similar to the projector used in the carrels. This should have a tray of slides or a filmstrip that has a large number 1 on the first image. The second image is a large 2, the third a 3. The number 4 is repeated so it occurs twice. Numbers 6, 9, 10, 13, and 14 are also repeated. This results in a total of twenty-six images the last one bearing the number 20.

Both the recorder and the projector should be plugged into the AC power outlet and turned on. The test cassette is placed in the recorder and the device started. If there is any doubt about how this is done, consult the manual that comes with the recorder. As the cassette plays, the first words heard are, "Image number 1 should be on the screen now. It should change to number 2 NOW." As the word NOW is spoken,

Test for CASSETTE RECORDERS - AFHRL/TT

RECORDER

Make _____

Model _____

s/n _____

TECHNICIAN

Name _____

Date _____

Type of Insp. Accept. _____
Prev. M. _____
Repair _____
Other _____

IMPULSE TEST (check each miss)

1	___	11	___
2	___	12	___
3	___	13	___
4	___ ___	14	___ ___
5	___	15	___
6	___ ___	16	___
7	___	17	___
8	___	18	___
9	___ ___	19	___
10	___ ___	20	___

Stop ___

TOTAL ERRORS _____

TIMING TESTS

Run _____

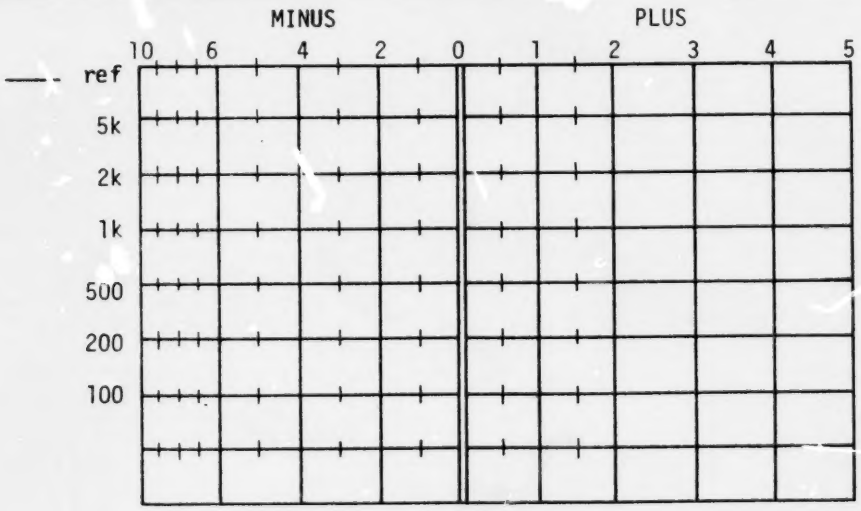
Rewind _____

PHYSICAL CONDITION

_____

_____

_____



TORQUE

1st _____

2nd _____

3rd _____

NOTES _____

_____

Accepted _____ Rejected _____

Figure 1. **Sample worksheet.**

HRL Media D/E Lab -6

an impulse on the tape should cause the projector to advance to the second image on which is the number 2. The tape now says, "Advance to number 3 NOW." The projector advances to 3. "The next is a double impulse." At this point, there are two advance impulses about two seconds apart. As a result, a number 4 appears on the screen very briefly and then is followed by a second number 4. If preferred a blank or scenic can be substituted for the first number 4. This continues with double impulses at 6, 9, 10, 13, and 14. At the conclusion of this portion of the test, a total of 25 impulses should have activated the projector resulting in the number 20 showing on the screen.

Scoring: The inspection test is scored by making a check mark behind each number to indicate that the impulse was missed. In order to be acceptable, the recorder must respond to *all* 25 advance impulses. If one or more are missed, the test should be repeated to assure that it was a device failure rather than an operator error of some sort. No device should be accepted that fails to respond consistently to all advance impulses. A single miss in a training session ruins the entire lesson.

If more than one recorder misses one or more impulses, check the worksheets to see whether or not the misses occur at the same point in the test. It could well be that the impulse on the tape is weak, resulting in advance failures that are not to be attributed to the recorder. If in doubt, the test tape should be corrected and the tests repeated. One of the major advantages of standardized inspections is to find the weak links in a system. A missed impulse may be caused by poor recording, poor duplication, or a projector failure as well as by a miss by the recorder. A systematic approach enables you to localize and correct the weakness.

Three other considerations merit attention here. One relates to devices with record capability. If the impulses are to be recorded by the device, then the record function should be checked at this point. Assuming that the impulses are recorded on the second channel, the impulses may be analyzed by recording a series of impulses, turning the tape over and playing it. The impulses are now on the audible channel and can be heard. If possible, these should be analyzed with an oscilloscope to assure that they meet ANSI PH 7.4 specifications. PH 7.4 calls for separate track systems to use tracks 3 and 4 for impulses, with a change impulse being within 5% of 1,000 Hz and stop impulse to be within 5% of 150 Hz. Duration of both should be within 7% of 0.45 second. Total harmonic distortion of cue tones should not exceed 10% (though this measurement may or may not be feasible depending on the equipment available).

The second consideration relates to devices that provide for both slide change (1,000 Hz) cue tones and program stop (150 Hz) capability. If the device utilizes both, the stop should be added following the change impulses that result in slides 2, 11, 16, 18, and 20 being on the screen.

The third consideration is that if more than one type of recorder is to be inspected, additional inspection tapes are required. We put the impulses on one tape and the other tests on a separate one. That way only the impulses have to be redone when a new impulsing system is encountered. We would strongly recommend, however, that any additional system comply with PH 7.4. Even within this, however, you might need one impulse tape without stops, a second one with, and possibly others with 2,300 Hz or 400 Hz tones.

If no other inspection is done, this one test should be accomplished on each recorder when it is received. Between the impulses and the oral instructions recorded on the tape, it provides a check of the essentials. It is placed first in this report to encourage its use. All you really have to do is make a test tape with the first recorder you open and use this tape to test the others. Careful attention should be paid to the clarity of the recorded verbal instructions and notes made of obvious physical damage. Such inspections will probably detect at least two-thirds of the defective devices.

Timing Test: There are three easy methods of verifying that the tape is running at the correct 1 7/8 ips speed. The simplest is to use a stop watch or watch with a sweep second hand. On the tape, make sounds and measure the time between them. For example the tape might say, "I am going to make a noise that sounds like this (bleep). Start your stop watch the next time you hear that noise. Here it is (bleep)." This is followed by several seconds of silence, then "Without stopping the watch, record the time at the next tone (bleep)." The sounds may be made by any short distinctive noise. Striking a glass ash tray with a coin or small screw driver is good. Tapping the edge of the microphone with a finger nail might also be used. In any event, make a series of tones or noises spaced so that the recorder is started and the running time noted at the end of about 35 seconds, 65 seconds and 100 seconds. A verbal warning is given just prior to each tone; i.e., "The final tone is coming (bleep)."

While this is crude, the timing can detect errors of 2% which is about as fine as there is any need to go. Sound variations of 10 to 15% probably are not noticeable in the average narration. However, such variations might results in impulse failures since the frequency of the impulse would be changed.

The speed can also be measured by the use of a special test cassette containing a strobe and a paper tape. These may be purchased at most hi fi shops. Probably the most reliable test, and certainly the one giving the most information, is to record a 1K tone on the test cassette and look at it on an oscilloscope. This will not only verify the overall speed, but also reveal deviations in both speed (frequency) and also amplitude. The oscilloscope inspection is highly recommended if at all possible.

Scoring: Any error of less than 2% probably has little or no meaning. However, errors larger than that probably should be investigated and corrected since they probably indicate that more serious deviations can be expected in the near future. Such deviations often suggest clutch or pulley problems and such problems often result in rather rapid deterioration. As a result, a 5% deviation is more serious for what it suggests might be anticipated in the near future than for any noticeable distortion that it itself would produce.

Rewind: A separate portion of this test requires that the tape be run to the end. This may be done rather rapidly by depressing the Fast Forward key. The tape is now wound on the take up spindle. Rewinding the tape requires that the entire tape be rewound. A C-60 tape will usually require about 40-45 seconds. While this may vary from brand to brand or model to model, most brands are fairly consistent within models. Any marked deviation from an average should be investigated. Too fast of rewind may break the tapes while excessive slowness is a waste of time and probably indicates a mechanical problem that can and should be corrected.

Response Range: The response range test is a relatively standard test used with various types of tape recorders. Test cassettes can be purchased but we have had relatively poor results with them. We generate our own. The signal from a tone generator is recorded on the best recorder available with the signal monitored by a digital voltmeter. All signals are input into the Radio/Phono jack. The source is monitored to assure 1 volt rms at all frequencies. The test cassette is then played back with the results from the Speaker/Earphone jack monitored on a VTVM and recorded on the worksheet. The result is usually not the flat response that is ideally desired, but is usually within one or two db from 100 thru 5000 Hz. This includes the range we are interested in for normal narrations. As the tape is played on new units and the results charted, a fairly good indication of frequency response can be obtained. For example, if 29 units in a shipment of 30 produce graphs similar to our original graph but the 30th one indicates marked deviations from this, the 30th should be checked carefully by a qualified maintenance person before it is accepted.

In monitoring the signal from the device being inspected, we use a load (normally 8 ohm) in conjunction with the VTVM to protect the amplifier. One easy way to do this is to plug a small speaker into the tape recorder and hook the VTVM leads across the speaker terminals. Check the manual to verify the impedence required. Most of them are 8 ohm. With the VTVM connected across the speaker to provide the load, adjust the volume control during the first tone (1 kHz played at normal level for calibration) and set the db scale reading to 0. All subsequent tones are plotted without change of the volume control providing an indication of the frequency response of the device. On the test tape, a voice tells what tone is coming next. For example, at the beginning it says, "The following tone is 1,000 cycles per second recorded at normal level for calibration purposes. All subsequent tones will be recorded at this level. Adjust the volume control to obtain a 0 db reading." After that it will merely state "The next tone is 500 cycles" or whatever the appropriate statement would be. The voice is put on to identify the tones but the dialogue should be kept brief since it is played each time the test is run. About the 65th time you hear your own voice say "The following tone is . . ." it does get to you.

This test might not be as standardized in some instances as we would like. Even with the VTVM, there are doubts as to whether the results should be attributed to characteristics of the initial recording or the unit being tested. However, comparative data that are meaningful can be obtained. We have had shipments where more than half of the devices have been judged to require attention based on these inspections. The subsequent attention by maintenance personnel at the supplier confirmed that adjustments and/or repairs were needed. These were performed without cost under the warranty.

Torque: The test for torque is simple and quick. There are torque measuring devices that consist of a small dynamometer literally enclosed in a cassette. When this is placed on the recorder and the play button depressed, a needle swings to indicate the grams of torque being applied by the recorder. Since this torque

turns the tape, it is essential that it be constant. Too much torque results in broken tapes. Too little results in tapes slowing down and stopping. The best indication we have found that clutches require attention is when the torque drops below 40 grams. At this point, the recorder is still playing but it probably will not continue to for long. These device failures while in use must be eliminated. If we can catch the problem in time, repairs can be made. This gauge is very much like the fuel gauge in your car. When it gets near the left hand limit, it is wise to gas up before the car stops running.

The torque meters we have are very inexpensive yet reliable. We use three different readings each from a different meter and then average the readings. The entire process takes less than a minute.

Scoring: We accept devices with readings between 40 and 55 grams. (Do not confuse this torque dynamometer that checks the torque developed by the recorder with torque testers for measuring the torque required to turn the tape in the cassette. One tests recorders, the other tests the cassette. The ideal situation is to find cassettes that require 20 grams and use them in recorders developing 45 grams.)

Physical Damage: Any evidence of physical damage or other defect is recorded under the notes at the bottom of the form. While it is difficult to describe just what to look for, usually it is obvious when you encounter it. Our notes include such entries as "no audible sound," "cannot open lid," and "plug broken on power cord." These infrequent and unexpected findings should be noted and appropriate action taken. In one case we found the wrong device inside of a box. When you consider the number packed by the factory, I suspect it is to be anticipated that someone would pick up the wrong box or device. However, unless the error had been detected and noted as soon as the box was opened, it would have been difficult to return it for an exchange.

Script for Test Tape. The following 1,000 cycle reference tone is used to adjust your meter to 0 db. After adjusting your volume to obtain 0 db, no further volume changes should be made. Test readings are read as variations from this reference tone. This tone may also be used to check tape speed.

The following tone is 5,000 cycles per second.

2,000 cycles
1,000 cycles
500 cycles
200 cycles
100 cycles

V. CONCLUSION

If an installation does not have a routine procedure for doing functional inspection testing, the result may be that defective media devices are issued to students or instructors. Acceptance testing can both avoid disruption of instruction and also save money by obtaining repair or replacement under the warranty on the device.

This memo has described a series of inspections for cassette recorders that can be performed to assure that devices are acceptable for their intended use. These inspections can be completed in 20 minutes and can be performed by instructional personnel who do not need to be technical experts.

It is recommended that the series of tests or inspection procedures proposed be completed on all cassette recorders as they are received. These include inspection of intelligibility of audio, physical condition, tape speed, impulse reliability, response range, and torque delivered to the tape. If the device has record capability, this should also be checked. The essential aspects of the inspection are grouped together within the first inspection. The later tests are highly desirable but may not be feasible in some instances.